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Risks for Functional Products – Empirical Insights from two Swedish Manufacturing Companies

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Abstract

Manufacturing companies are increasingly offering add-on services and functional products (FPs) to secure their future competitiveness. For product oriented organizations, this represents a significant transition in their business models, leading to several risks and uncertainties. In this study, we attempt to identify and understand these potential risks that can hinder manufacturing companies from offering FPs. To reach the stated purpose, we have adopted a quantitative research approach and undertaken eighteen explorative interviews in two large Swedish manufacturing companies. Our results show ten potential risks that can negatively affect manufacturing companies. For example, contractual risks, breakdown or technical risk and inappropriate organizational structural risk were found to be the most prominent risks for FPs. These risks are categorized into three specific dimensions related to business models, namely value creation, value delivery and value capture. Thus, the study provides critical understanding towards how manufacturing companies can be better prepared for transforming into a successful FP provider through mitigating of identified FP risks.

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Keywords: business models; functinal products; add-on services; value creation; value delivery; value capature; risk; uncertainty; contracts product life-cycle; product-service systems

1. Introduction

The integration of products and services by manufacturing companies is a growing trend in today's globally competitive business environment. Several literature streams have evolved around offering integrated product and service solutions throughout of product life-cycle. In particular, emerging literature on functional products (FPs) captures this transitional phenomenon. An FP [1] offer comprises of integrated developed hardware, software, a service support system and the management of operations that together enable functional provision [1]. Commonly, a level of availability for the function to be provided is agreed upon in the contract and the FP provider needs to monitor and keep a certain impact and control of the FP during the contract duration. Although, widely recognised as an important transition for most manufacturing companies, how to implement and successfully offer FPs has not been studied widely. We propose that a central issue to consider during the early stages of FP development is related to considerations of business model. A business model describes how companies create, deliver and capture value [2] and can potentially provide critical insights

[1] The FP concept has similarities with, for instance, Functional Sales, Extended Products, Total Care Product, Product-Service Systems (PSS), or Industrial Product Service Systems (IPS[2]), in the sense of increasing the focus on soft parts such as services and the term product-services is used to relate to all these concepts. The FP, focus on complex and availability offers that are based on availability and includes the development process of the offer. Therefore, the definition is more exclusive as e.g. for PSS and we use the term add-on services to relate to product-services offer where services area additional to a product sale.

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on how to transition towards offering FPs as this will result in a new and revised FP business model [3].

The recent study by Lindström et al. [4] have identified several business model elements for FPs and one of the most critical elements is the "risk level and availability" which is related to the FP business model. More specifically, a FP business model includes additional risks that need to be carefully analysed in advance. This is the case because the FP provider sustains certain control and influence on the function delivery during the life-time of the FP. With the FP business modes, the companies will undertake new responsibilities and liabilities which were not part of the traditional product sale oriented business models. Increased responsibility is strongly connected to higher level of risks which need to be considered by the company and managed accordingly.

At present, the current literature on risks as well as their management for FP provision is very limited and further empirical knowledge would contribute to a better understanding of FP development. In most cases, the companies have some level of experience in-service provision and therefore it is important to address the changing risks linked to more complex product-service offering, such as FPs. In particular, a comprehensive set of the risks that needs to be considered by the FP provider in the planning and development stage would advance the current literature. This implies having a quite broad view on FP risks, which is defined as all potential reasons that lead to an outcome that is different from the planned or expected outcome [5]. Therefore, we adopt an all-inclusive view on FP risks, which does not differentiate between risks, uncertainties or challenges, and taken them together into factors that could potentially lead to deviation from the expected outcome. To this end, the purpose of this study is to apply explorative an case study approach in order to identify risks that are related to FP provision.

The rest of the paper will continue with an overview of the literature on risks in research areas related to FPs. This is followed by an explanation of the methodology choices made during the study. After that, the findings are presented and the paper ends with discussion and conclusion.

2. Literature Overview

The integration of products and services has been described under various literature streams, such as FPs, product-service systems, industrial product-service systems, servitization, etc. These literature streams highlight different levels of product and service integrations. For example, the product-service system literature classifies three generically established levels of product-service integrations, namely product-, use-, and result-orientation [6]. Essentially it can be concluded that the degree of product-service integrations are largely affected by the business model logics. According to Teece [2], business models describe the design or architecture of the value creation, delivery and capturing mechanisms it employs. These various degrees can be clearly differentiated. Value creation describes how the organization transforms resources and inputs into offers [7]. The value delivery concerns how the offer is provided and made accessible for the customer. Finally, the third aspect that is described by a business model, value capturing, is according to Bowman and Ambrosini [7] the price paid for the created value.

For an FPs, this implicates that the value is created as function provision is guaranteed during the life-time of the hardware or the respective contracting period [4] and the risks related to the availability of the function is shifted from the customer to the FP provider. For the value delivery, a complex supply network is constructed that enables the FP provider to deliver the function and to influence the process through the service support system whenever needed. In order to guarantee the function provision, a suitable monitoring and control system is necessary. The value capturing differs significantly from a product sale because the revenues for the FP provider occur over the time the function is provided and the customer pays for the delivered function. Compared to those integrated product-service business models that sell services as an add-on to the physical product, for FPs value is further created through the benefits of additional services and terms that are agreed upon besides the product sale. The risks related to the functionality and availability of the FPs are largely shifted based on the FP business model used.

More specifically, the risk levels for each particular party differ significantly based on the underlying business models. Richter et al. [8] even view it as the aim of the business model to evenly allocate risks, chances and incentives. The notion that the risks increases for the FP providers has been described frequently in literature [9- 11] but usually without mentioning any details about these specific FP risks. Tukker [12] sees the risk premium that the provider can charge the customer as a major reason for offering product-service combinations. Furthermore, the possibility of risk-pooling [13] leads to the fact that the provider is more capable in handling the risk compared to the customer [14].

Studies that address specific risks are most commonly focused around risks that affect the in-service phase. For research conducted about services as an add-on this means in most cases default risks as e.g. unexpected machine breakdowns [15]. Studies describing FP applications are in addition frequently referring to behavioural risk that is related to the fact that the customer does no longer own the hardware [14]. Kuo [16] made a study that clearly showed that customer behaviour changes depending upon the ownership, as they may be much more carefully when it is their own property. Another risk is related to financial issues, because the manufacturer needs to give guarantees in terms of availability of the equipment [17]. A related aspect studied by Romero Rojo et al. [18] highlights the obsolescence of hardware is usually part of long-term contracts.

However, Tonelli et al. [19] show that risks are not only related to the in-service phase but also important to consider during the implementation of what has been offered. Exemplified on offering services as an add-on for hospital consumables, risks identified are lack of alignment amongst decision makers, the presence of a powerful anti-sponsor or internal barriers which resist change. In addition, Mont et al. [20] emphasize organizational barriers as well as possible damage for the FP provider's image. In studies related to FP

provision, the risk of resistance from the customer side towards FP offers is important to consider [21]. For example, customers could perceive a loss of control with FPs which may cause discomfort and may lead them to not opting for FPs [22].

Some researchers also have tried to develop frameworks or clusters to categorize the different types of risks that can occur when integrating products and services. For example Meier et al. [9] uses the life-cycle of the offer (initial stage, design & manufacturing, in-service stage and disposal stage) in order to categorize possible risks. Another example is provided by Erkoyuncu et al. [23] in order to identify which risks that needs to be included in the cost estimation process. The following risk categories were identified to have the main impact: commercial, affordability, performance, training, operation and engineering. These are categorized as technical, commercial, financial and behavioural risks [4].

3. Methodology

This study is based on an empirical study at two manufacturing companies offering integrated product and services and which hold the ambition to offer FPs. To reach the stated purpose, we adopted a qualitative research approach, which used semi-structured and open-ended interviews. This meant that we developed a guide for the interviews before hand through our understanding of the current literature. We collected data from two companies, company A and company B, which are industrial members of the Faste Laboratory at Luleå University of Technology, Sweden. is the Faste Laboratory is a VINNOVA Excellence centre for FP innovation. This university and industry collaboration supported us with data collection because the respondents were motivated and had reasonable well-developed knowledge about FPs.

The company A is an international world leading provider of construction equipment. They offer products and services in more than 125 countries through proprietary or independent dealerships. Currently they offer several services in addition to their machines like maintenance contracts, extended warranty and to keep track of error codes and fuel consumption. An example of planned FP offer for company A can be sale of functions based on an agreed availability level for a specific contracted duration. Company A and their dealers would in this case sustain the ownership of the hardware. Twelve respondents were interviewed which are actively involved in the current service provision and development at the company. These were from top management and middle management levels, e.g., after-sale products and process development managers, director for product-service development, and project manager for FP implementation.

The company B manufactures press hardened automobile parts for global market. The unit of interest in this case is the tooling department located in Sweden which internally supplies to the press hardening factories across the globe. Add-on services currently offered by company B are maintenance training, simulations and process optimization. To improve their product-service offer portfolio, they are currently developing an FP which is based on guaranteeing a certain “number of strokes” that their tools will perform for a specified duration. We conducted interviews with six respondents from different parts of the organization, e.g., head of product, project manager for product-services, and financial project manager.

The interviews usually started with a short introduction about the specific focus of the study and how that is integrated in the overall research project before the respondents were ask to explain provide their background information. This was followed by an open question about which risk or risks the respondent viewed to be related with service provision and FP provision. We started with this open question about risks to facilitate that they would be able to provide their unbiased view. This question was later followed up by discussion on more specific risks that we had already identified based on literature review. This also indicates which risk they see as the most dominant and serious one. During the course of the interviews, different risks identified from the literature were mentioned in order to find out how relevant those were perceived by the respondents. At the end of the interview the respondents were also asked whether they see the company they work for as a risk averse, risk neutral or risk taking company.

The eighteen interviews took anywhere between 60 and 90 minutes each and the researchers took notes during the interviews as well as most of the interviews were recorded for transcription. Both case companies also shared internal documents before and during the interviews (i.e. secondary data) that were used to speed-up the process of understanding their operations. These documents and the transcribed interview notes build the basis for the analysis.

4. Industry Perspective on Risks for Functional Products

Both companies studied are well aware of the importance of FPs for their future operations in order to differentiate themselves from competitors and to sustain customer loyalty as a high quality supplier. However, in practise the case companies seldom move directly from pure product sales to FP provision. Instead they look to gain experience from supplying product-services by offering add-on services. Therefore, in this section we will identify the risks that are related to business models for services as an add-on and FP business models and compare them. Furthermore, in order to fulfil the purpose and to have a broad view on risks related to all areas connected to FP provision, we use the three aspects of the business model definition, *value creation, value delivery and value capturing*, to structure our analysis.

4.1 Risks affecting the value creation

Value is created when the company offers something that the customer has a need for – and the customer is able to use or benefit from it. For services offered as an add-on, one major risk can be seen in the fact that customers as well as the dealers that are supposed to sell the services do not see the benefits and their need for the particular services. In addition, the cost benefits that create a high value for the customer and are related to the particular service are usually very hard to

show in the short term and credible data may be hard to collect. This will make the offer unattractive and there is a risk that the customers only see the direct costs related to the purchase of the service and are not willing to pay for that. In many cases, the customers even expect those services for free, so putting charges on them will have a negative impact on the manufacture's image. The attractiveness of the services can also be affected when services are offered unconnected to each other, which mainly is a result from a lack of intra-organizational working group collaboration. Further, this affects how much value is created because bundled services can increase the value for the customer significantly. Another risk mentioned several times by the respondents is that customers of globally operating companies belong to diverse cultures and it may be that in certain cultures services are perceived to have limited added value.

Risks related to value creation for FPs were mainly found to be related to organizational structures. FP provision requires the establishment of a new organizational structure and new routines. When this is not handled effectively there is a high risk that no value can be created for the customers. In addition, this needs to be supported by a strategic shift through the whole company towards becoming an FP provider. The change should not take excessive time in order to be able to respond to the customers' current needs and to have an attractive offer. However, the risk is high that employees both at the provider and dealer side are not given enough time and skills to develop good FP offers that are attractive to customers. The fact the FP provision is risky may hinder the change of the organizational structure even more especially in risk adverse companies. But not only does the provider's organization impose risks on the FP provision, also the customers organization can be a source of risks. In these cases, FP may not be attractive for the customer's current way of working and the customer may be resistant to change the established way of working. FP could even be perceived by dealers and customers as some type of competition as it will reduce their scope of operations. Another risk can be identified by looking at the target group for FP. The provider may only offer FPs to large and mature companies that are well aware of the processes, but the value that can be created for new and inexperienced customers may be much higher. Furthermore, the culture of the customer can present a major risk for the value creation of FPs because some cultures may not favour that someone else is becoming part of their operations and that they may not own the hardware in use anymore. Surprisingly, and in contrast to literature, one respondent responded that there could be a risk that the quality of the hardware could potentially be reduced when used as an FP. This may be the case because only the quality of the outcome is evaluated by the customer and not the quality of the hardware.

Comparing risks related to the value creation of services as add-on and FPs, it is clearly visible that the required organisational change for FP provision increases the risk level significantly. Further, the customer's organisational structure also needs to be considered, as well as cultural aspects, which may cause even more extensive negative effects. On the other hand the communication of the benefits of the offer is not perceived as important for FP compared to services as add-on.

4.2 Risks affecting the value delivery

Value delivery describes how the offer is provided to the customer in order to make it usable- and in some cases also provide insight on how the offer is used. Negative effects on the value delivery of services as add-on are to a major extent related to the contract that is signed between both parties. If the contract is too complex and comprehensive, there is a risk that the customer is unwilling to reach an agreement and no service is sold. However, it is crucial to have clarity about what is included or excluded in the services, otherwise FP provider risks' being accountable for tasks that were not intended to be part of their agreement. The contract should also define which monitoring and control mechanisms are to be used. Regarding business models, where the services are sold as an add-on to the products, information sharing is hard to enforce and monitoring can be difficult. Another risk is that the dealer who is appointed to carry out the service does not have the capabilities to do so and therefore the output of the add-on services may not meet customers' expectations.

One major risk that negatively affects the value delivery of FPs is lack of capital or funds available to sustain the ownership of the hardware and rely on the installment based revenue stream. Even law and tax issues (e.g. related to internal customers or cross-border transactions) can make it impossible to deliver FPs. Regarding contractual concerns, besides complex contracts discouraging customers, the FP provider also needs to effectively manage its supply chain relationships. It is important to upfront agree upon who owns the contract and who can enforce it. Lack of clarity can lead to a situation where the value delivery is at risk because of unclear responsibility within the supply chain. The same is valid for the information sharing process. Especially communication is essential throughout the whole supply chain to reduce the risk of insufficient function provision. Here also the internal organisational structure must be able to adapt to FP provision and such adaption can be difficult for established supply chains that are designed to offer products and not FPs. Furthermore, the fact that resources needed for FP delivery are harder to precisely plan in advance creates a risk for lack of resources like workforce and spare parts required to deliver the agreed functions.

Looking at the differences between risks that affect value delivery of services as an add-on and FPs, the financial aspect is a major issue for FP provision. The clarity of the contract is important in both cases, but it may even be easier in FP contracts to receive information because the ownership is sustained. In addition, the difficulty of establishing appropriate supply chains creates still a higher risk level for FP provision. Quite similar is the level of risks that is related to the availability of resources and capabilities needed to deliver the agreed service or function.

4.3 Risks affecting the value capturing

Value capturing is about getting paid for the provided offer and risks, which significantly affects in this context how much revenue is secured by the provider. The most obvious risk affecting value capturing is the breakdown or technical failure risk. If a larger number of malfunctions than expected occur during the contract duration, the provider would have to incur additional costs (which were not accounted for earlier during the planning). In addition, other negative effects on revenues from services as add-on are mainly related to difficulties in monitoring and information sharing. For example, there is a risk that the customer may not follow the maintenance instructions (if the customer is responsible for that). This can make it hard to prove afterwards who is responsible for any downtime or breakdowns. Such events may of course have financial consequences for the provider. Depending on the supply chain structure, there is a risk that it is not possible to monitor independent dealers what they charge the hardware/software manufacturer for and whether their work was necessary in that case. Furthermore, the attitude of the customer may change and there is a serious risk for adverse behaviour. This may be the case because the customer feels that they can earn something extra when using the service more extensively. Further, information asymmetries and lack of monitoring possibilities increase the likelihood of risks. There is also the risk that providers are not able to capture value from their services as they only focus on selling spare parts and to improve customer loyalty.

For FP provision revenues which occur over time, based on how much the function is used, therefore an important risk to consider is that the demand will be lower than predicted when the appropriate price per unit was calculated. Another risk, which is especially important when internal customers are served, is that it might not be economically feasible to enforce fulfilment of agreement from a provider perspective. Additionally, it is also important to consider a changing attitude of the customer because of the risk for less careful behaviour when not owning the hardware anymore. Additionally, cultural differences can influence the outcome of the FP agreement and how successful the FP application will be.

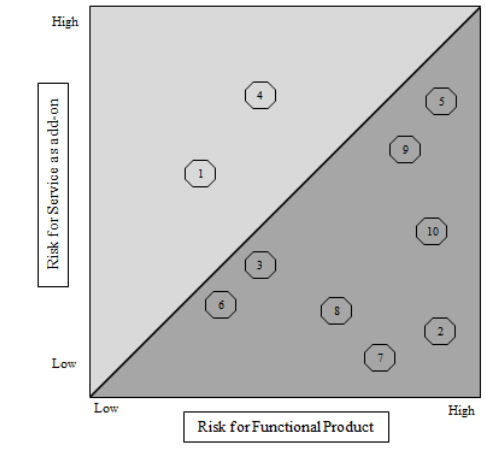
The comparison of risks affecting the value delivery of services as an add-on and FPs, shows that the breakdown risk is very crucial in both cases but that the consequences are even more extensive in the case of FP provision. The same can be said for changing attitudes of customers, it is a risk in both cases but consequences can be much bigger in the case of FPs. In contrast, risks related to monitoring may be easier to handle in the case of FPs because the provider has more influence or even the ownership of the product. Overall it can be said that it is important to not only include breakdown risk in the risk calculations because there are many other risks affecting the final outcome.

5. Discussion and Conclusion

To change an established and embedded product oriented business model is a complex undertaking for any company. We find that offering services as an add-on has been practiced by case companies for a longer time and they did so by largely rely on existing business model. In contrast, offering FPs significantly affects the traditional product sale oriented business model by introducing several risks. This is because increased responsibility over the life time of the hardware or contract duration leads to different types and levels of risks. Fig. 1 illustrates these risks and the extent of their impact for the case companies as they offer add-on services and FPs. Such presentation enables us to provide a holistic view towards better understanding of the identified risks.

It is important to recognize that the risk level is not necessary increasing as provider shifts towards offering FPs. Especially monitoring and information sharing is easier to enforce because the FP provider will sustain ownership or a certain control of the hardware which leads to a better position while agreeing on those issues. Further, the communication of value is easier in the case of FPs because the risks and responsibilities are significantly reduced for the customer. However, most of the risks increase for FP business models – which needs to be compensated by higher charges matching the risks transferred to the provider. The organisational structure and the financial capacity have a much higher probability to have negative effects in the case of FP provision compared to add-on services. Risks related to contracts and adverse behaviour are high in both business models, but even more significant for FPs.

Comparing the risks identified in this study to the literature it can be recognised that many of the risks can be found in both parts. Risks related to technical and commercial aspects could not be validated as they were not significantly higher in our study. However, risks related to contracts, organisational structures and the supply chain were identified in our study as high impact risk and these have been largely overlooked in the current literature.



1. Hard to communicate value
2. Inappropriate organisational structure
3. Cultural antipathy
4. Monitoring and information sharing
5. Too extensive or difficult contracts
6. Lack of resources and capabilities
7. Lack of financial capacity
8. Complex supply chain
9. Adverse behaviour
10. Breakdown risk

Fig. 1. Risks and their importance in case of service as add-on and FP.

Overall it becomes evident that the risks are a very important factor for FP business model development. The paper contributes to literature with how risks can affect integrated business model by outlining various risks and their importance for services as add-ons and FPs. Understanding the risks is important while developing complex business models such as FPs [4], as well as how to set up the supply chain and the contracts necessary, to be able to provide a complete function with an agreed upon level of availability over time during the contract duration. To be able to manage parts of the operational risks related to FP provision, a monitoring system is required to be able to, preferably in a proactive manner, avoid malfunctions and unplanned stops.

Future research should focus on the management of the identified risks. In particular, contract design is an interesting area because the companies found contracts as a major issue that affects the FP provision in the early stage. Furthermore, literature provides yet very little about how complex supply chains effect FP provision and therefore more work needs to be done in this direction. Another interesting aspect to look at in the future would be whether the quality of the hardware is always improved or whether FP could have opposite result at least for parts not critical for the function provision.

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References

[1] Lindström J, Löfstrand M, Karlberg M, Karlsson L. A development process for functional products: Hardware, software, service support system and management of operation. International Journal of Product Development. 2012;16(3):284-303.

[2] Teece DJ. Business models, business strategy and innovation. Long Range Plann. 2010;43(2-3):172-194.

[3] Schuh G, Klotzbach C, Gaus F. Service provision as a sub-model of modern business models. Production engineering. 2008;2(1):79-84.

[4] Lindström J, Plankina D, Nilsson K, Parida V, Ylinenpää H, Karlsson L. Functional Products: Business model elements. Proceedings of the 5th CIRP Industrial Product-Service Systems (IPS2) Conference. 2013:251-262.

[5] Erkoyuncu J, Roy R, Shehab E, Wardle P. Uncertainty challenges in service cost estimation for product-service systems in the aerospace and defence industries. Proceedings of the 1st CIRP Industrial Product-Service Systems (IPS2) Conference. 2009.

[6] Baines TS, Lightfoot HW, Steve E, et al. State-of-the-art in product-service systems. Proceedings of the Institution of Mechanical Engineers.Part B, Journal of engineering manufacture. 2007;221(10):1543-1552.

[7] Bowman C, Ambrosini V. Value creation versus value capture: Towards a coherent definition of value in strategy. Br J Manage. 2000;11(1):1-15.

[8] Richter A, Sadek T, Steven M. Flexibility in industrial product-service systems and use-oriented business models. CIRP journal of manufacturing science and technology. 2010;3:128-134.

[9] Meier H, Roy R, Seliger G. Industrial product-service systems--IPS2. CIRP annals. 2010;59(2):607-627.

[10] Richter A, Steven M. On the relation between industrial product-service systems and business models. Operations Research Proceedings 2008. 2009:97-102.

[11] Azarenko A, Roy R, Shehab E, Tiwari A. Technical product-service systems: Some implications for the machine tool industry. Journal of Manufacturing Technology Management. 2009;20(5):700-722.

[12] Tukker A. Eight types of product–service system: Eight ways to sustainability? experiences from SusProNet. Business Strategy and the Environment. 2004;13(4):246-260.

[13] Spring M, Araujo L. Service, services and products: Rethinking operations strategy. International journal of operations production management. 2009;29(5):444-467..

[14] Roy R, Cheruvu KS. A competitive framework for industrial product-service systems. International Journal of Internet Manufacturing and Services. 2009;2(1):4-29.

[15] Steven M. Risk management of industrial product-service systems (IPS2)–How to consider risk and uncertainty over the IPS2 lifecycle? In: Leveraging technology for a sustainable world. Springer; 2012:37-42.

[16] Kuo TC. Simulation of purchase or rental decision-making based on product service system. The international journal of advanced manufacturing technology. 2011;52(9-12):1239-1249.

[17] Sundin E, Öhrwall Rönnbäck A, Sakao T. From component to system solution supplier: Strategic warranty management as a key to efficient integrated product/service engineering. CIRP journal of manufacturing science and technology. 2010;2(3):183-191.

[18] Romero Rojo FJ, Roy R, Shehab E, Wardle P. Obsolescence challenges for product-service systems in aerospace and defence industry. Proceedings of the 1st CIRP Industrial Product-Service Systems (IPS2) Conference. 2009.

[19] Tonelli F, Taticchi P, Starnini Sue E. A framework for assesment and implementation of product-service systems strategies: Learning from an action research in the health-care sector. WSEAS Transactions on Business and Economics. 2009;6(7):303-310.

[20] Mont O, Dalhammar C, Jacobsson N. A new business model for baby prams based on leasing and product remanufacturing. J Clean Prod. 2006;14(17):1509-1518.

[21] Stoughton M, Votta T. Implementing service-based chemical procurement: Lessons and results. J Clean Prod. 2003;11(8):839-849.

[22] Ng I, Yip N. Identifying risk and its impact on contracting through a benefit based-model framework in business to business contracting: Case of the defence industry. Proceedings of the 1st CIRP Industrial Product-Service Systems (IPS2) Conference. 2009:207-215.

[23] Erkoyuncu JA, Roy R, Shehab E, Cheruvu K. Understanding service uncertainties in industrial product–service system cost estimation. The International Journal of Advanced Manufacturing Technology. 2011;52(9-12):1223-1238.